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Economic and Poverty Impacts of a Voluntary Carbon Reduction for a Small Liberalized Developing Economy: The Case of the Philippines

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Summary

This paper analyzes the economic and poverty effects of a voluntary carbon emission reduction for a small liberalized economy—the Philippines. The simulation results indicate that tariff reductions undertaken by the Philippine government between 1994 and 2005 reduced the cost of fossil fuels thereby resulting in an increase in carbon emissions. The economic cost of reducing carbon emissions by imposing a carbon tax appears minimal as the reduction in consumer prices due to tariff reductions outweigh the increase in production cost from the imposition of a carbon tax. Overall results suggest that maintaining carbon emissions relative to 1994 levels appears to be a sensible alternative for the country.

Keywords: Climate Change, Carbon Emissions, International Trade, Computable General Equilibrium, Micro-Simulation, Macro-Micro Models, Philippines

JEL Classification: C68, D58, F18, I39, Q56

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1. Introduction

The Philippine government has actively participated in various multilateral agreements involving the environment. Among others, the government has signed the United Nations Framework on Climate change (UNFCC) in 1992 and the Kyoto Protocol in 1998. In 2003, the Philippine congress ratified the Kyoto Protocol paving way for the creation a Kyoto consistent Greenhouse Gas National Action Plan for the country.

The Philippine government has undertaken substantial trade-policy reforms since the 1980s to enhance domestic producer efficiency and encourage exports. This program was further reinforced by the emergence of the World Trade Organization (WTO) and other multilateral trade arrangements forcing the government to legislate significant tariff reductions in the mid-1990s.

Demand for fossil fuels in the Philippines has been increasing since the last decade. As a result, the country's fossil fuel related carbon dioxide emissions have increased by 72 percent between 1992 and 1998 (WRI 2003). Forecast indicates that this trend will continue as fossil fuel utilization is expected to grow by 62 percent between 2003 and 2012 (PEP 2003), suggesting that future carbon dioxide emissions are expected to increase by more than half within the next few years.

This research analyzes the economic and poverty effects of a voluntary carbon emission reduction for the Philippines in light of the country's trade liberalization agenda. A static Computable General Equilibrium (CGE) model calibrated to 1994 data and linked to a household survey with 24,797 households is utilized to assess the impact of reducing carbon emissions via the imposition of a carbon tax under a liberalized developing economy.

Although assessing the economic and welfare impacts of carbon taxation is not new to the literature, this paper contributes by focusing on the static interaction between tariff reduction and carbon taxation—in order to evaluate the economic and poverty impacts of a green reform in a small liberalized developing economy. Three counterfactual simulations are undertaken to shed light on this issue and to answer questions such as: (a) does the tariff reductions undertaken by the Philippine government between the years 1994 and 2005 resulted in an increase in carbon dioxide emissions? (b) what is the impact of the government's decision to increase household income taxes to offset the foregone tariff revenue as a result of tariff reduction? (c) will the imposition of a carbon tax, to restrain carbon emissions under a liberalized economy be harmful to firms, households, and the government?

2. Carbon Dioxide and Global Warming

The growing concern towards global warming arising from the rapid accumulation of atmospheric greenhouse gases has, since the last decade, been part of the international policy agenda. In fact, the Kyoto Protocol was instituted in order to promote cooperative multilateral agreements aimed at controlling anthropogenic[2] greenhouse gas emissions. In addition, the Kyoto protocol establishes binding reduction commitments among Annex I[3] countries beginning the initial implementation period 2008 to 2012.

The Rationale behind the growing clamor for global greenhouse gas emission reduction, in spite of plausible future impacts, has been due to the increasing evidence of human induced warming. Although natural variations contributes to the accumulation of green house gases, recent scientific evidence show that the observed warming in the last 50 years has been attributable to human activities (IPCC 2001a). Among the greenhouse gases, carbon dioxide (CO_2), the main anthropogenic greenhouse gas, has been identified as the foremost contributor to climate change. CO_2 comprise more than half as well as account for 60% of the total changes in greenhouse gas concentration, hence contributing largely to the enhanced greenhouse effect (IPCC 2001a).

The combustion of fossil fuels, coupled with land use changes brought about by deforestation resulted in higher atmospheric greenhouse gas concentrations (mainly of CO_2) since the last century. Furthermore, the sustained economic dynamism of developed countries, as well as the continued industrialization of developing countries greatly increased the amount of CO_2 emissions since the last decade. Worldwide CO_2 emissions arising from fossil fuel combustion alone was estimated at 23,172.20 million metric tons in 1999, representing an 8.9 percent increase relative to 1990 levels (WRI 2003). Although 64 percent of these emissions originate from developed countries, the growing concern on the increasing share of developing countries' CO_2 emissions has been

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[2] IPCC define anthropogenic as those resulting from or produced by human beings
[3] Developed Countries and Economies in Transition, refer to Kyoto Protocol (1998) for a complete list

recognized. This is because developing countries are under no legal binding commitment to reduce their future CO_2 emissions under the Kyoto Protocol. As such, it has been argued that a reduction agreement that does not include developing countries will achieve little gains (Mckibbin and Wilcoxen 1999). In the same vein, to prevent any carbon leakage[4] problem, it has been argued that developing countries must likewise be part of the reduction agreement.

3. Philippine Trade Reform Program

The first phase of the Philippine Trade Reform Program (TRP-1) started in 1981 with three major components: (a) the 1981–1985 tariff reduction, (b) the import-liberalization program (ILP), and (c) the complementary realignment of the indirect taxes.

In 1991, the government launched TRP-2 to realign tariff rates over a five-year period. The realignment involved the narrowing of tariff rates through a series of reductions of the number of commodity lines with high tariffs and an increase in the commodity lines with low tariffs. In particular, the program was aimed at the clustering of tariff rates within the 10–30-percent range by 1995. This resulted in a near-equalization of protection for agriculture and manufacturing by the start of the 1990s, reinforced by the introduction of protection to "sensitive" agricultural products. Despite the programmed narrowing of the tariff rates, about 10 percent of the total number of commodity lines were still subjected to a 50-percent tariff by 1995.

In 1992, a program of converting Quantitative Restrictions (QRs) into tariff equivalents was initiated. In 1994, the country became part of the WTO, committing to gradually remove QRs on sensitive agricultural product imports by switching towards tariff measures (with the exception of rice).

In 1995, the government started implementing TRP-3 aimed at adopting a uniform 5-percent tariff rate by 2005. Tariff rates were successively reduced on the following: capital equipment and machinery; textiles, garments, and chemical inputs; manufacturing

[4] Carbon leakage is the situation where CO_2 emission reductions undertaken by developed countries (or parties subject to emission reduction within the agreement) may well be offset, or even be surpassed by an increase in developing country emissions (or parties not subject to emission reduction)

goods; and non-sensitive components of the agricultural sector. Through these programs, the number of tariff tiers and the maximum tariff rates were reduced.

By 1998, it became evident that the planned uniform tariff rate will not materialize as TRP-4 was undertaken to recalibrate the tariff-rate schedules implemented under previous rounds of TRPs. Initially, the tariff-rates of 22 manufacturing goods that were identified as globally competitive were increased. Subsequently in January 2001, the tariff schedules on all product lines (except sensitive agricultural products) were amended within the period 2001–2004.

Table 1: Structure of Nominal Tariff Protection (1990-2005)

Sectors	1990	1998	1999	2000	2001	2002	2003	2004	2005
All Industries	33.33	11.32	10.25	8.47	8.28	6.45	6.60	6.82	6.82
Coefficient of Variation	0.44	0.96	0.91	0.99	1.04	1.17	1.06	1.07	1.07
% of Tariff Peaks	-	2.24	2.24	2.48	2.50	2.69	2.53	2.71	2.71
Agriculture	36.73	15.9	13.2	11.5	12.3	10.4	10.4	11.3	11.3
Coefficient of Variation	-	1.07	1.14	1.3	1.23	1.31	1.22	1.17	1.17
Fishing and Forestry	11.71*	9.4	8.9	6.7	6.7	5.8	5.7	6.0	6.0
Coefficient of Variation	18.21**	0.63	0.70	0.66	0.62	0.45	0.48	0.57	0.57
Mining and Quarrying	29.24	3.3	3.3	3.1	3.2	2.8	2.7	2.5	2.5
Coefficient of Variation	-	0.42	0.41	0.24	0.23	0.38	0.40	0.48	0.48
Manufacturing	34.66	11.38	10.35	8.5	8.28	6.39	6.57	6.76	6.76
Coefficient of Variation	-	0.93	0.88	0.95	1.0	1.13	1.03	1.03	1.03
Number of Tariff Lines	6,193	7,363	7,363	7,363	7,363	7,363	7,363	7,382	7,382

*Fishing; **Forestry
Sources: Manasan and Pineda (1999); Aldaba (2005)

Table 1 summarizes the structure of nominal tariff protection from 1990 to 2005. The economy-wide average tariff rate fell from 33.33 percent in 1990 to 6.82 percent in 2005, with the highest reduction in tariff rate experienced by the mining and quarrying sector at 91 percent, followed by the manufacturing sector with 80 percent. The pace of tariff reduction is faster in both mining and the manufacturing sector as a result of the relative protection afforded by the government towards agriculture. Notably, table 1 shows that the policy reversals initiated under TRP-4 resulted in a marginal increase in tariff rates for all sectors except mining and quarrying.

Although the current tariff rates are already low, an analysis of tariff peak and coefficient of variation by Aldaba (2005) reveals that the current tariff structure is heavily distorted[5]. The tariff legislations under TRP-4 (including policy reversals) increased not only the tariff lines but more importantly the percentage of tariff peaks and coefficient of variation. From 1988 to 2005, overall tariff peaks increased from 2.24 to 2.71 percent while overall coefficient of variation increased from 0.44 to 1.07 percent. Over-all, the various rounds of TRPs were beset by policy reversals due to economic and political reasons, particularly lobbying by interest groups.

Table 2: Sources of Government Tax Revenue (in percent share)

Tax Revenue	**1990**	**1994**	**1998**	**2002**	**2004**
Income taxes	32.5	33.9	44.1	45.6	46.5
Property Tax	0.2	0.1	0.1	0.1	0.1
Taxes Goods and Services	33.5	28.0	31.4	29.6	28.0
Tariff	30.7	30.3	18.3	19.5	20.5
Other Taxes	3.1	7.6	6.1	5.2	4.8
Total	**100**	**100**	**100**	**100**	**100**

Source: 2005 Philippine Statistical Yearbook

The implementation of the various rounds of TRPs also resulted in dramatic changes in the government's revenue structure (table 2). In 1990, tariff revenue accounted for 30 percent of total government revenue in contrast to its 20 percent share in 2004. The revenue share of taxes on goods and services declined from 33.5 to 28 percent, while the share of income taxes rose from 32.5 to 46.5 percent suggesting that the foregone tariff revenues as a result of tariff reductions have been compensated by an increase in income taxes imposed on households.

[5] The tariff peak is the proportion of products with tariffs exceeding the three times the mean tariff, while the coefficient of variation is the ratio of the standard deviation to the mean.

4. Philippine Energy Utilization and Carbon Dioxide Emissions

Demand for energy has been increasing since the last decade. The relative energy intensity of the economy increased from 1.67 barrels of fuel oil (BFOE) per ten thousand peso output in 1990 to 2.71 BFOE in 1998, reflecting that past economic growth was largely stimulated by energy utilization (PEP 2003). This increased energy dependence resulted in the country discharging 75,988 thousand metric tons of CO_2 in 1998, representing a 72 percent increase relative to 1990 levels (Earthtrends 2003). Emissions mainly originate from the combustion of fossil fuels (both solid and liquid fuels) and cement manufacturing (table 3)

Table 3: Philippine Carbon Dioxide (CO_2) Emissions[a] (in thousand metric tons of CO_2)

Total emissions, 1998	75,988
Percent Change since 1990	72%
Emissions as a percent of global CO_2 production	0.3%
Emissions in 1998 From	
Solid fuels	13,612
Liquid fuels	55,729
Gaseous fuels	0
Gas flaring	0
Cement manufacturing	6,646
Per capita CO_2 emissions, 1998	1.0
Percent Change since 1990	40%
CO_2 emissions (in metric tons) per million dollars Gross Domestic Product, 1998	925
Percent Change since 1990	39%
Cumulative CO_2 emissions 1990-1999 (in billion metric tons)	1,399

[a] Only Fossil fuel related emissions
Source: WRI (2003) / www.earthtrends.wri.org (2003)

Projections indicate that energy utilization and demand for fossil fuels will grow by 5.5 and 6 percent per year from 2003 to 2012 respectively, to complement the projected 5.4 percent annual growth in Gross Domestic Product. Table 4 shows the estimated CO_2 emissions from energy, forestry and agriculture. In the 1990s, CO_2 emissions from fossil fuel combustion accounted for only 27%, while deforestation coupled with land use changes as well as environmentally degrading practices in the agricultural sector accounted for 73% of the total CO_2 emissions in the country. The rapid deforestation of about 100,000 hectares per year due to logging activities, coupled with residual forests clearing until the 1990s, resulted in a 55% share of forestry to over-all CO_2 emissions

Table 4 Projected Carbon Dioxide Emissions*

Sector	1990	2000	2010	2020
Energy	40,926	67,136	126,940	238,260
Forestry	81,360	-43,163	-25,448	-2,324
Agriculture	26,718	28,779	29,600	30,547

* Does not include gasses other than CO_2
Source: Asia Least-Cost Greenhouse Gas Abatement Strategy (ADB, 1998)

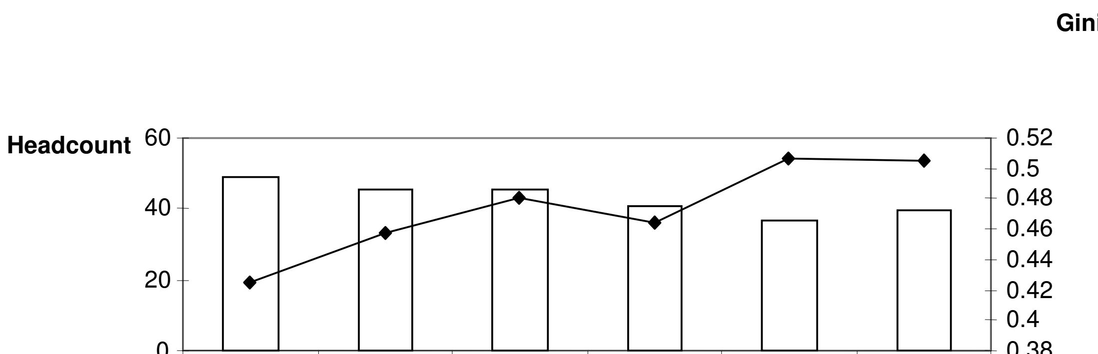
On the other hand, projections indicate an increasing trend for energy and agriculture but a reversing direction for the forestry sector. The share of energy related CO_2 emission will grow by 482% in a span of three decades due to increasing fossil fuel dependence of the Philippine economy implying that almost 90% of the total future CO_2 emissions in the country will come mainly from the energy sector. The forestry sector became a net sink starting the year 2000 from a net emitter in 1990 owing to reforestation efforts. However, the projected fall in the residual dipterocarp forests dramatically reduces forestry sector's sink capacity by the year 2020 (ALGAS 1998).

5. Poverty and Inequality

Widespread poverty and the persistence of income inequality have been endemic since the post-war era (Balisacan, 1996). Although various government policies to address these concerns have been implemented, the extent of poverty reduction over the last three decades however have been gradual, that by the turn of the century, the Philippines recorded the highest incidence of absolute poverty when compared with other East Asian Economies (Balisacan, 2003).

Poverty is fundamentally a rural problem. Almost half of the rural population lives below the poverty line in the year 2000. This is in stark contrast when compared with those in the urban areas wherein poverty incidence is only a fifth of the population. Figure 1 presents the evolution of the poverty headcount index and the Gini coefficient from 1985 to 2000. The poverty headcount index dropped continuously from 49.2 percent in 1985 to 36.9 percent in 1997 but then worsened to 39.5 percent in 2000 as a result of the 1998 El Niño phenomenon and the Asian financial crisis. On the other hand, income inequality steadily increased over this period as the Gini coefficient worsened from 0.42 in 1985 to 0.51 in 2000.

Figure 1. Income distribution and poverty headcount: The Philippines (1985–2000)



	1985	1988	1991	1994	1997	2000
Headcount	49.2	45.4	45.2	40.6	36.9	39.5
Gini	0.42	0.46	0.48	0.46	0.51	0.51

Source: FIES 1985, 1988, 1991, 1994, 1997, 2000

An equally important consideration in assessing poverty and inequality in the Philippines is the peculiar but commonly held notion within policy dialogues about the nature, causes and factors that affect them. First, it is widely argued that economic growth does not benefit the poor because of the absence of trickle down effect. Second, it is inherently believed that spatial as well as sectoral dimensions contribute largely to poverty and inequality. However, Balisacan (2003) finds that these notions are not entirely accurate as his study reveals that: (a) past episodes of economic growth indeed contributed to poverty reduction; and (b) intra-spatial together with intra-sectoral rather than inter-spatial and inter-sectoral dimensions contributed largely to the causes of poverty and inequality in the Philippines. That is, within region rather than between region inequality arising from differences in Physical possession and human assets explain the foremost reason of inequality in the Philippines (Balisacan, 2003).

6. Brief Survey of Literature

Thus far, only a few studies have analyzed the economy-wide link between the economy and the environment in the Philippines. Aldaba and Cororaton (2002) employed a CGE model to analyze the pollution impacts of trade liberalization in the 1990's. Their findings reveal that the pollution effects of trade liberalization are relatively small with carbon monoxide (CO) increasing marginally by 0.05 percent.

Coxhead and Jayasuriya (2002) analyzed the potential economic, poverty and environmental effects of trade liberalization in the Philippines using a CGE model called APEX (Clarete and Warr, 1992). Although APEX has no explicit environmental linkage, the authors were able to infer on the probable environmental impacts of trade liberalization using "detailed prediction of input and output changes" particularly on the forestry sector. However, the impacts of trade liberalization on CO_2 emissions were not analyzed.

Corong (2003) employed a static CGE Model to assess the economic impacts of reducing carbon emissions in the Philippines. Simulation results indicate that imposing a 1,250 peso carbon tax (1994 Philippine peso) reduces carbon emissions by five percent, and leads to a 0.2 percent decline in over-all output. Moreover, households experience welfare improvements whenever the generated carbon tax revenue is used to reduce the income tax being paid by households. The model however, has only one representative household, and does not capture the likely poverty changes that may arise from the imposition of carbon tax.

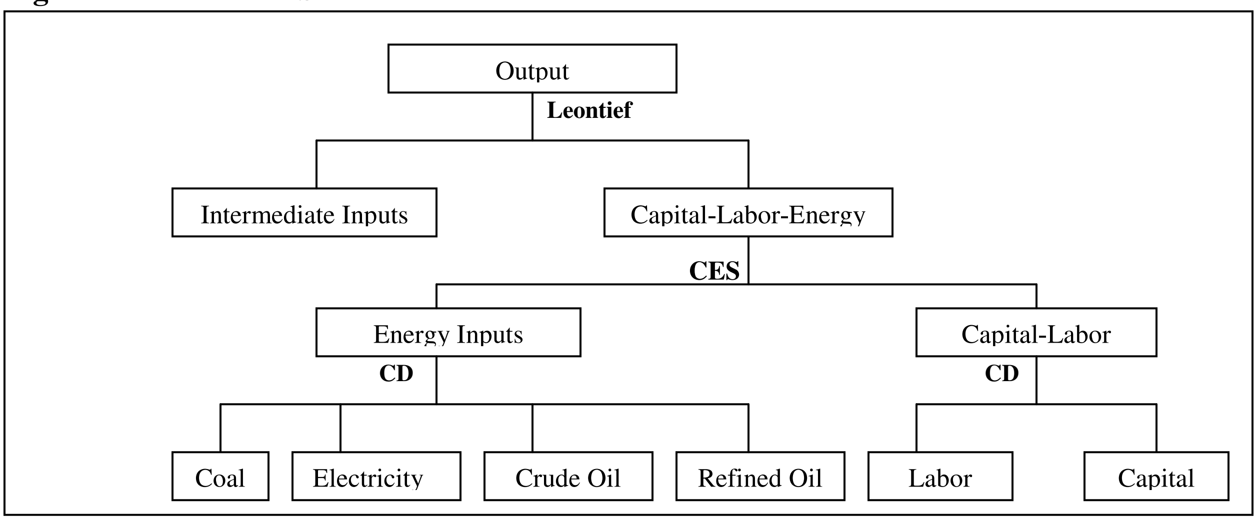
7. The Model

The model is a static CGE calibrated to the 1994 Philippine social accounting matrix (SAM) and is linked to a household survey with 24,797 households. There are 10 producing sectors composed of: 1 agriculture, 6 manufacturing including 4 energy producing sub-sectors, and 3 services including the government. The CGE model has 12 representative households classified according to educational attainment.

7.1 Firms and Supply Side

Figure 1 presents the nested production structure of the model (assuming constant returns to scale). Gross output is determined via a four-stage process. The first stage involves the optimal determination energy input through Cobb-Douglas (CD) aggregation. On the second stage, the aggregated labor input is combined with capital to form a capital-labor composite using CD aggregation. Then, the capital-labor and energy bundle is combined through constant elasticity of substitution (CES) aggregation in the third stage. Gross output is produced through a Leontief function of intermediate inputs, energy bundle, and the capital-labor bundle.

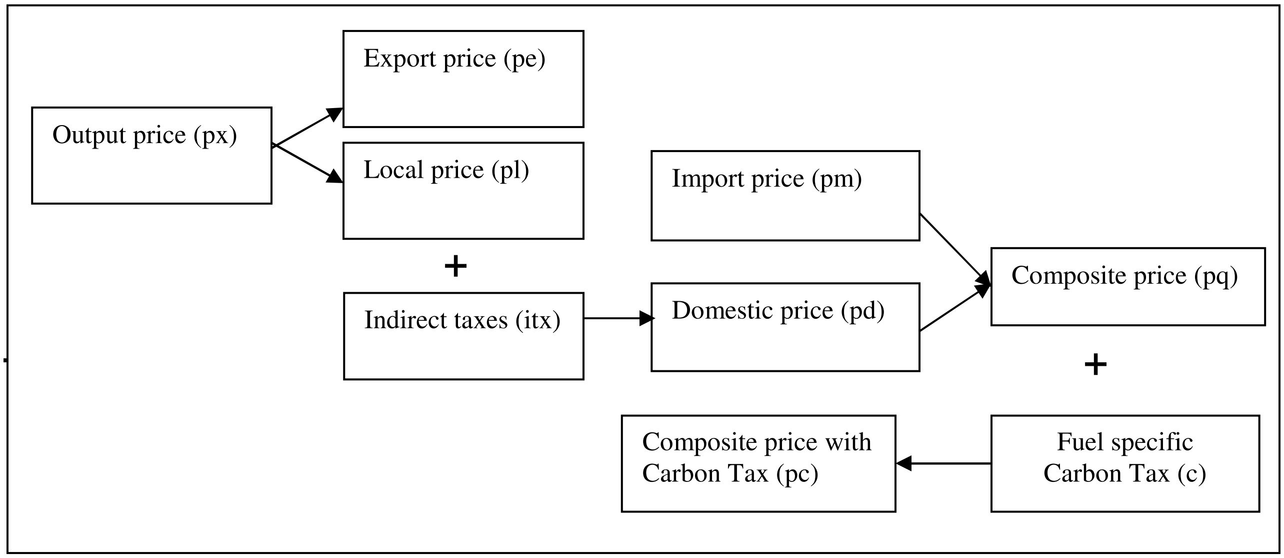
Figure 1: Production Structure



The supply side of the model is specified as a constant elasticity of transformation (CET) between export and domestic sales with the allocation between exports and domestic sales depending on the export price, local price and the elasticity of substitution.

Figure 2 shows the basic price relationships in the model. The price Output price (Px) is determined as a composite price of exports (Pe) and local prices (Pl). Adding indirect taxes to local price determines the domestic prices (Pd), which when combined with import price (Pm) results in the composite or consumer price (Pq). The fuel specific ad valorem carbon tax rate is then added to determine the composite price of a fossil fuel with the carbon tax (Pc).

Figure 2: Basic price relationships in the model



7.2 Households, Demand Side, and Poverty

The demand side is specified as a constant elasticity of substitution (CES) function between imports and domestic good. This is otherwise known as the Armington or small country assumption to account for product differentiation between imported and domestically produced goods. The allocation between imports and domestic good depends on the import price, domestic price, and the elasticity of substitution.

There are 12 Representative households groups (RHGs) in the CGE model with each household maximizing their own utility subject to a Cobb-Douglas Utility function. They are classified based on educational level and place of residence, with each one having their own labor and capital endowments.

However, merely using the RHGs in the CGE to assess the household poverty impacts arising from a policy shift is not adequate. To address this, the year 1994 family income and expenditure survey (FIES) covering 24,797 households was utilized. To ensure consistency between the RHGs and the respondents in the FIES, the households in the latter were categorized by using the household characteristics found in the former. Thus, this involved classifying each household in the FIES based on educational attainment and place of residence in order to match the RHG classifications found in the CGE.

Figure 4: Illustration of the link between the CGE and the Household Survey

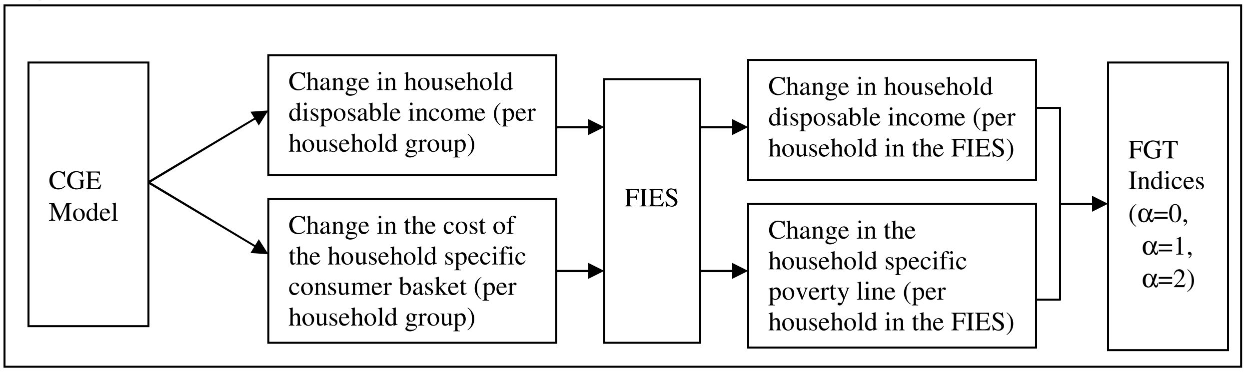


Figure 4 provides a stylized illustration of the link between the CGE model and the FIES. Following a policy shock, the change in each representative household's disposable income and the cost of the household specific consumer basket (weighted consumer prices) from the CGE model is applied to each household of the same category in the FIES. The percentage change in each RHGs disposable income from the CGE model is applied to all households in the same category implying that each household in the FIES will have a new level of disposable income. Similarly, the percentage change in the cost of the household specific consumer basket for each RHG in the CGE model is used to change the assigned nominal value of the poverty line for each household in the FIES. Both the changes in disposable income and poverty line in the FIES, then allows the possibility of capturing the changes in individual household poverty characteristics through the Foster, Greer, and Thorbecke (FGT) class of poverty measures.

Poverty is measured through Foster-Greer-Thorbecke (FGT) P_α class of additively decomposable measures (Foster, Greer and Thorbecke 1984). The FGT poverty measure is:

$$P_\alpha = \frac{1}{n} \sum_{i=1}^{q} \left(\frac{z - y_i}{z} \right)^\alpha \qquad (1)$$

where α is the poverty aversion parameter, n is the population size, q is the number of people below the poverty line, y_i is income, and z is the poverty threshold.[6]

[6] The poverty threshold is equal to the food plus the non-food threshold, where threshold is defined as the cost of basic food and non-food requirements.

Poverty indices are computed before and after the policy shock using the actual distribution of income in the FIES. The FGT poverty measure depends on the values that the parameter α takes. At α = 0, the poverty headcount is calculated by accounting for the proportion of the population that falls below the poverty threshold. At α = 1, the poverty gap is measured indicating how far on the average the poor are from the poverty threshold. Finally, at α = 2, the poverty-severity index is revealed. The severity index is more sensitive to the distribution among the poor as more weight is given to the poorest below the poverty threshold. This is because the poverty-severity index corresponds to the squared average distance of income of the poor from the poverty line, giving more weight to the poorest of the poor in the population.

7.3 Carbon Emissions, Government Revenue, and Carbon Taxes

Carbon emissions are endogenous into the system. It is computed by using carbon specific fuel coefficients multiplied by the actual fossil fuel use of each sector:

$$Carbon\_emission_j = \varepsilon_j \sum_i \psi_j \cdot En\_input_{ji} \tag{2}$$

where: $Carbon\_emission_j$ is the total carbon emissions of fuel j. ε_j is the carbon emission coefficient of fuel j; ψ_j is the physical conversion coefficient of fuel j; and En_input_j is the intermediate energy input j used by sector i

Government revenue is generated from: direct income tax on households and firms; Indirect taxes on goods and services; and Tariff. The imposition of carbon tax results in an additional government revenue represented by ctxrev.

$$ctxrev = \sum_i \sum_j tc \cdot \varepsilon_j \cdot \psi_j \cdot En\_input_{ji} \tag{3}$$

Where ctxrev is the carbon tax revenue; tc is the Carbon tax; ε are the fuel emission coefficient of fuel j; ψ_j are the physical conversion coefficient of fuel j; and En_input_{ji} represent the intermediate energy input j used by sector i

Following Zhang (1998), given the government revenues by kind of fuel j, the carbon tax can then be converted into fuel-specific advalorem tax rate, through the ratio of government fuel-specific revenues to the total values of domestic absorption of the fuel given by:

$$adtx_j = \frac{tc \cdot \varepsilon_j \sum_i \psi_j \cdot En\_input_{ji}}{PD_j \cdot D_j + PIM_j \cdot IM_j - Pl_j \cdot EX_j} \quad (4)$$

Where: $adtx_j$ is the per fuel ad valorem tax rate; PD_j is the Domestic price of fuel j; D_j is domestic demand for fuel j; PIM_j is the Import price of fuel j; IM is the Import of fuel j; Pl_j is the local price of fuel j; EX_j is the Exports of fuel j

The computed per fuel ad valorem tax rate can then be applied to the domestic price of fuel expressed as:

$$PC_j = (1 + adtx_j) \cdot Pq_j \quad (5)$$

Where PC_j represents the composite price of fuel j with carbon tax

7.4 Model Closure

Government Account Balance: Nominal government spending varies as a result of changes in nominal prices, but real government spending is held fixed in order to abstract from possible welfare effects as a result of changes in government spending. Holding real government spending fixed prevents the government from influencing the simulation results through changes in government consumption. Nominal total government income is held fixed. Any changes in government income from tariff reduction or from the carbon tax is compensated by changes in household income taxes, implying that all simulations adhere to equal yield scenarios. For instance, a reduction in government income arising from tariff reduction results in a pro-rated increase in income tax rates imposed among households. Similarly, an increase in government income arising from carbon taxation results in a pro-rated decrease in income tax rates imposed among households. Government savings is flexible to allow for changes in endogenously determined price of total real government consumption.

Carbon Tax Revenue: The generated carbon tax revenue is recycled back into the economy by decreasing—in a pro-rated manner—the income taxes paid by household. This implies that households who pay higher taxes at the base receive more reduction compared to those households who pay less.

Savings-Investment Balance: The savings-investment balance is fixed. Total real investment is fixed to prevent any inter-temporal welfare effects. The current account balance is likewise held fixed, which is analogous to the assumption of constant foreign savings in order to abstract from any welfare effects linked to foreign capital inflows. The real exchange rate[7] clears the foreign sector. Imports and exports are allowed to vary as a result of the changes in the real exchange rate. The nominal exchange rate is the model's numéraire.

Labor Market: The labor market assumes a neo-classical closure wherein Labor supply is always equal to labor demand.

8. Baseline Statistics

8.1 Structure at the Base

Table 5 presents the economic structure at the base. The pattern of trade shows the dominance of the manufacturing sector, with light manufacturing and heavy manufacturing accounting for more than half of total trade (both exports and imports). Indeed, manufacturing accounts for about 58 percent of total exports, outperforming both the services and agricultural sectors. The Light manufacturing sector, which includes food processing, semi-conductor, and textile and garments generates 52 percent of total exports.

On the other hand, both manufacturing and services allocate a significant part of their output to the international market. The most export intensive sector is light manufacturing (25.8 percent), followed by crude oil (17.5 percent), services (16.9 percent), and transport (15.7 percent), whereas agriculture, refined oil, and electricity have the least export intensity. Similarly, 89 percent of total imports accrue to the manufacturing sector with the remainder going to services and agriculture sectors with 10 and 1 percent respectively. This enormous share stems from the low valued added import-intensive assembly-type operation nature of the manufacturing sector particularly in the semi-conductor, textile and garments, machinery and assembly. Once again, light

[7] The real exchange rate is the nominal exchange rate multiplied by world export prices divided by local prices.

manufacturing has the highest import share with 60 percent, followed by heavy manufacturing with 21 percent.

Table 5: Structure at the Base

SECTORS	TRADE				PRODUCTION				
	Exports,%		Imports,%		Value Added			Share	
	Share	Export as a percentage of sectoral output	Share	Import as a percentage of composite commodity	$(KLEVA/X)_i$	$(KLVA/X)_i$	$(EVA/X)_i$	$(KLVA_i / KLVA)$	Labor to Capital Ratio
Agriculture	6.5	7.5	1.5	1.8	74.1	71.5	2.7	20.0	91.4
Light Manufacturing	52.2	25.8	59.6	28.2	36.1	32.0	4.1	20.9	71.8
Heavy Manufacturing	6.1	13.4	20.5	33.7	50.6	47.2	3.4	7.0	76.3
Refined Oil	1.1	5.8	3.0	13.9	70.8	20.2	50.6	1.3	46.0
Coal	-	-	0.1	21.0	56.1	42.8	13.2	0.1	122.9
Crude Oil	0.03	17.5	5.7	97.2	71.1	62.7	8.4	0.0	32.4
Electricity	0.2	1.2	-	0.0	81.8	49.8	32.0	2.4	31.6
Services	29.5	16.9	8.8	5.7	69.6	65.5	4.1	36.9	51.7
Transport	4.3	15.7	0.9	3.6	62.6	42.2	20.4	3.8	149.3
Government	-	-	-	0.0	72.9	69.0	3.9	7.6	-

Source: Author's calculation based on the 1994 Social Accounting Matrix
Note: KLEVA= Capital-Labor-Energy Value Added, KLVA = Capital-Labor Value Added, EVA = Energy Value Added, X = Output, Subscript i refers to sectoral output or value added

The most import-intensive sector is crude oil with 97 percent, implying that a substantial amount of oil available in the domestic market comes from abroad. In the same vein, coal and refined oil are highly import intensive with 21 and 14 percent share respectively. The share of capital-labor-energy value added to total output is more than half for all sectors except light manufacturing, which utilizes minimal value added due to import intensive-assembly type operation nature of the semi-conductor and textile and garments sub-sector. Nonetheless, electricity, agriculture, and refined oil have the highest value added content with 82, 74, and 70 percent respectively.

The highly energy intensive sectors, defined in terms of energy to value added ratio are refined oil (50 percent), electricity (32 percent), coal (13 percent), and crude oil (8 percent). Among the non-energy producing sectors, transport is the most energy intensive with 20 percent energy to value added ratio.

The utmost user of value added is services with 37 percent, followed by light manufacturing, and agriculture with 21 and 20 percent respectively. The agricultural sector generally has a higher labor to capital ratio due to the highly labor intensive nature of agriculture in the country

8.2 Energy Mix

Table 6 shows the energy utilization of all sectors in the economy. Refined petroleum, owing to its nature of production—converting crude oil for final consumption—utilizes for more than one fifth of total available energy in the economy, whereas crude oil sector consumes the least amount of energy in the economy. The entire economy's energy mix is composed of 48 percent refined petroleum, 30 percent electricity, 20 percent crude oil, and 1 percent coal.

Similarly, table 6 presents the sectoral energy mix in the economy. The foremost user of refined petroleum is transportation with 96 percent, followed by the energy producing sectors. As expected, the refined petroleum sector is the most intensive consumer of crude oil[8]. The heavy manufacturing sector is the most intensive user of coal, whereas light manufacturing is the principal user of electricity.

Table 6: Energy Mix

SECTORS	Share in Total Energy Value Added (%)	Energy Mix (%)			
		Refined Petroleum	Crude Oil	Coal	Electricity
Agriculture	5.7	70.0	-	0.01	30.0
Light Manufacturing	20.4	35.9	-	0.5	63.7
Heavy Manufacturing	3.9	35.4	2.1	28.3	34.2
Transportation	13.8	96.7	-	0.0	3.3
Services	17.5	34.3	-	-	65.7
Government	3.3	44.0	-	-	56.0
Refined Petroleum	23.9	15.4	84.3	-	0.3
Coal	0.1	89.9	-	-	10.2
Crude Oil	0.04	93.2	-	-	6.8
Electricity	11.4	95.2	-	0.7	4.1
TOTAL	100	48.17	20.27	1.26	30.31

[8] It should be noted however that refined petroleum does not actually consume all of its crude oil input, but rather converts them for final consumption.

8.3 Households

Table 7 shows the sources of household income. Income generated from labor wages is the main source of income for all households (only urban-female with high school and college education as the exception), followed by earnings from capital and other sources such as government transfers, dividends, and remittance income. The share in total income presented in the bottom part of table 6 reveals a disproportionate earning capacity between urban and rural households. Of the total labor income generated in the economy, only 32 percent went to rural households with the remaining 68 percent accruing to urban households. This is likewise true for capital income with 35 and 65 percent going to rural and urban households respectively. Even worse, the category other income shows rural households receiving only 18 percent compared to the 82 percent share for urban households

Table 7: Income Sources at the base

Household Category		Urban					Rural			
		Labor	Capital	Others	Total		Labor	Capital	Others	Total
Elementary	Male	56.2	32.5	11.3	100		52.3	39.9	7.8	100
	Female	45.2	32.4	22.4	100		47.2	36.1	16.8	100
High School	Male	51.6	29.9	18.5	100		52.6	36.2	11.3	100
	Female	33	30	37	100		29.2	34.2	36.7	100
College	Male	54.7	31.9	13.4	100		56.3	25.7	18	100
	Female	37	31.3	31.7	100		44.4	18.9	36.6	100
Share in total income		68	65	82			32	35	18	

In 1994, about 41 percent of the population of 67 million was below the poverty threshold (Table 8). Urban areas, where majority of the industries are located, had the lowest poverty level while rural areas have the highest. Three observations are noticeable from table 8. First, poverty is more prominent in the rural area. Second, poverty is more pronounced with less educated people. For instance, household heads with college education (skilled workers), regardless of gender, are less susceptible to poverty. Third, male-headed households in the rural areas are much more vulnerable to poverty than their female counterparts.

Table 8: Poverty Indices at the base

Households		Index				Index		
		Headcount	Gap	Severity		Headcount	Gap	Severity
All Philippines		40.6	13.5	6.1				
		Urban				Rural		
Elementary	Male	46.7	16	7.3		62	21.7	10.1
	Female	28.7	8.8	3.7		46	15.4	7.1
High School	Male	22.4	6.3	2.6		41.5	13.3	5.7
	Female	10.1	2.5	1		27.8	9	3.9
College	Male	3.7	0.9	0.3		11.1	2.2	0.7
	Female	3.7	0.4	0.1		4.8	1.6	0.6

9. Simulations

Three simulations are undertaken to assess the likely impacts of imposing carbon tax under a liberalized economy. The First policy simulation involves a nominal tariff reduction of 60 percent to assess the economic and poverty impacts of tariff reductions between 1994 and 2005. The second policy simulation involves the imposition of a 385 peso carbon tax[9] per ton of carbon emissions to isolate the impact of imposing a carbon tax in the economy. Finally, the third simulation combines the first and second policy shocks—a nominal tariff reduction of 60 percent and a 385 peso carbon tax per ton of carbon emissions—to maintain carbon emissions relative to 1994 levels under a liberalized economy.

Trad-Lib 60 percent nominal tariff reduction.
The government increases income tax paid by households to offset the foregone revenue from tariff reduction.

Carb-Tax A 385 peso carbon tax (1994 peso) per ton of carbon emissions.
The Government recycles the generated carbon revenue by reducing income taxes imposed among households

Trad-Car 60 percent nominal tariff reduction with a 385 peso carbon tax to maintain carbon emissions relative to 1994 levels under a liberalized economy.
The government increases (decreases) income tax paid by households if the foregone revenue from tariff reduction is higher (smaller) than the revenue earned from carbon tax.

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[9] The 385 peso carbon tax (1994 peso value) is the same amount needed to maintain carbon emissions relative to 1994 levels under a liberalized economy.

All simulations employ equal yield scenarios with household direct income tax functioning as a compensatory measure. The compensatory direct income tax adjusts endogenously in the model. Essentially, there are three possibilities. First, tariff reduction reduces government revenue forcing the government to increase household income tax rates to maintain budgetary position. Second, carbon taxation increases government revenue, compelling the government to reduce household income tax rates to maintain budgetary position. Finally, the government may either increase (or decrease) the income tax rate whenever the revenue lost from tariff reduction is higher (lesser) than the revenue earned from the carbon tax.

9.1 Simulation 1: Trad-Lib

Macro effects**:** The tariff reductions lead to an 11 percent fall in the local price of imported products resulting in a 5.2 percent increase in overall imports (Table 9). Consumer prices decreases by 5.7 percent, giving rise to a 0.2 percent increase in consumption as consumers substitute cheaper imports for domestic goods. Similarly, the tariff reductions reduce the price of imported intermediate inputs, resulting in a 4-percent dip in the domestic cost of production.

Table 9: Macro Effects (in percent Changes)

Macroeconomic Variables	**Trad-Lib**	**Carb-Tax**	**Trad-Car**
Overall nominal tariff rate	-60	-	-60
Prices:			
Import prices in local currency	-10.55	-	-10.55
Consumer prices	-5.66	0.24	-5.46
Domestic cost of production	-4.45	0.12	-4.36
Real exchange rate	4.78	-0.07	4.71
Import volume	5.24	-0.02	5.21
Export volume	4.83	-0.07	4.75
Domestic production for local sales	-0.96	-0.02	-0.99
Consumption (composite) goods	0.23	-0.02	0.21
Overall output	0.20	-0.02	0.17
Carbon emissions	2	-2	-

The reduction in the domestic cost of production brings about a real-exchange rate depreciation (by 4.8 percent), making Philippine-made products relatively cheaper in the international market. Producers reallocate towards the international market resulting in a

4.8 percent increase in exports, and a 1 percent reduction in allocation for domestic sales. The reduction in the domestic cost of production allows firms to expand their production giving rise to a 0.2 percent increase in overall output. However, the tariff reductions reduce the local price of imported fossil fuel inputs resulting in a 2 percent increase in economy-wide carbon emissions.

Sectoral Effects: The tariff reductions result in an output expansion for the manufacturing, transport, and refined oil sectors, but an output contraction for agriculture, services, coal, crude oil, and electricity sectors (Table 10). The reduction in coal and crude oil output results from consumer and firm substitution towards cheaper coal and crude oil imports. Similarly, tariff reduction results in a decline in consumer prices (Pc_i) especially among the energy producing and the manufacturing sectors. This is not surprising as these sectors experience a higher tariff reduction compared to other sectors. For instance, the local import prices of energy drops substantially with refined oil, crude oil, and coal import prices falling by 9, 12, and 20 percent respectively. Thus, their respective consumer prices go down as well (crude oil, refined oil, and coal by 20, 10, and 6 percent respectively).

The availability of cheap energy inputs allows the electricity sector to reduce its consumer prices by 5 percent. Hence, electricity intensive sectors such as light- and heavy- manufacturing benefit. Moreover, the reduction in electricity prices coupled with the availability of cheap intermediate inputs, allows both light- and heavy- manufacturing sectors to reduce their local cost of production. This makes their products relatively cheaper in the international market, hence both their exports increases by at least 5 percent.

Nevertheless, both sectors' imports increases as well (7.4 and 6.4 percent for light- and heavy- manufacturing respectively) owing to their inherent production structure concentrating on import-intensive and assembly-type operation with little value added content. The transportation sector gains from cheaper energy prices, resulting in a 0.4 percent increase in transportation output. However, the services sector stands out as the biggest loser arising from the substantial reduction in its consumer prices, hence, profitability.

Table 10: Sectoral Effects (in percent Changes)

SECTORS	Price Changes (%)					Volume Changes (%)				
	δpm_i	δpd_i	δpc_i	δpx_i	δpl_i	δm_i	δe_i	δd_i	δc_i	δx_i
Simulation 1: Trad-Lib										
Agriculture	-3.4	-2.7	-2.7	-0.5	-2.7	0.2	1.8	-0.7	-0.7	-0.5
Light Manufacturing	-11.8	-4.9	-7.2	0.7	-4.9	7.4	5.7	-1.0	1.6	0.7
Heavy Manufacturing	-10.0	-4.2	-6.4	0.3	-4.2	6.4	5.1	-0.5	2.0	0.3
Transport	0.0	-5.2	-5.0	0.4	-5.2	-6.8	5.9	-0.6	-0.9	0.4
Services	0.0	-4.0	-3.8	-0.7	-4.0	-6.3	3.3	-1.6	-1.9	-0.7
Government	-	-	-	2.3	-	-	-	-	-	2.3
Refined Oil	-9.2	-10.9	-10.6	2.2	-10.9	-0.9	16.3	1.3	1.0	2.2
Coal	-12.1	-4.7	-6.6	-2.1	-4.7	7.9	-	-2.1	0.3	-2.1
Crude Oil	-20.3	-12.4	-20.1	-4.0	-12.4	2.4	12.4	-7.7	2.2	-4.0
Electricity	-	-5.0	-5.0	-0.1	-5.0	0.0	6.1	-0.2	-0.2	-0.1
Simulation 2: Carb-Tax										
Agriculture	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1
Light Manufacturing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Heavy Manufacturing	0.0	0.0	0.0	-0.1	0.0	-0.1	-0.1	-0.1	-0.1	-0.1
Transport	0.0	0.7	0.6	-0.3	0.7	0.6	-1.0	-0.2	-0.2	-0.3
Services	0.0	0.1	0.1	0.1	0.1	0.2	0.0	0.1	0.1	0.1
Government	-	-	-	0.1	-	-	-	-	-	0.1
Refined Oil	0.0	1.1	3.6	-0.9	1.1	0.5	-2.1	-0.8	-0.6	-0.9
Coal	0.0	0.3	17.7	-0.3	0.3	0.1	-	-0.3	-0.2	-0.3
Crude Oil	0.0	-0.5	2.7	-0.3	-0.5	-0.9	0.3	-0.4	-0.9	-0.3
Electricity	-	0.9	0.9	-0.1	0.9	0.0	-1.1	-0.1	-0.1	-0.1
Simulation 3: Trad-Car										
Agriculture	-3.4	-2.7	-2.8	-0.4	-2.7	0.2	1.9	-0.6	-0.6	-0.4
Light Manufacturing	-11.8	-4.9	-7.2	0.7	-4.9	7.5	5.6	-1.0	1.6	0.7
Heavy Manufacturing	-10.0	-4.2	-6.4	0.2	-4.2	6.3	5.1	-0.6	2.0	0.2
Transport	0.0	-4.6	-4.4	0.1	-4.6	-6.3	5.0	-0.8	-1.0	0.1
Services	0.0	-4.0	-3.7	-0.7	-4.0	-6.2	3.4	-1.5	-1.8	-0.7
Government	-	-	-	2.3	-	-	-	-	-	2.3
Refined Oil	-9.2	-10.0	-7.4	1.3	-10.0	-0.6	14.1	0.5	0.3	1.3
Coal	-12.1	-4.4	9.7	-2.3	-4.4	8.0	-	-2.3	0.2	-2.3
Crude Oil	-20.3	-12.7	-18.0	-4.3	-12.7	1.5	12.7	-8.1	1.3	-4.3
Electricity	-	-4.2	-4.2	-0.2	-4.2	0.0	5.0	-0.3	-0.3	-0.2

Where: pm_i : import (local) prices, pd_i : domestic prices, pc_i : composite commodity prices, px_i : output prices, pl_i : local prices, m_i: imports, e_i : exports, d_i : domestic sales, c_i : composite commodity, x_i : total output, δ : change

Value Added.: The Price of the energy value added (PEVA) declines as a result of the tariff reduction. Similarly, the price of the capital-labor value added decreases for most sectors with the exception of light manufacturing and refined petroleum due to the increase in the cost of capital facing them (table 11). In spite of this, the average cost of sector specific capital for the whole economy falls by 0.9 percent. On the other hand, the demand for labor increases for output expanding sectors (such as light manufacturing, heavy manufacturing, transport, and refined oil) as over-all wage falls by 1.5 percent. The resource reallocation impact of all these is that labor moves towards output expanding sectors.

Table 11: Effects on Value Added (in percent changes)

SECTORS	VALUE ADDED						δr_i	Labor Demand
	Volume			Price				
	$\delta KLEVA_i$	$\delta KLVA_i$	δEVA_i	$\delta pkleva_i$	$\delta pklva_i$	$\delta peva_i$		L*
Simulation 1: Trad-Lib								
Agriculture	-0.5	-0.5	-0.5	-1.7	-1.4	-8.9	-1.9	-1.1
Light Manufacturing	0.7	0.7	0.8	-0.7	0.1	-7.0	0.8	1.7
Heavy Manufacturing	0.3	0.2	0.3	-1.0	-0.5	-7.8	-0.3	0.6
Transport	0.4	0.4	0.4	-3.8	-0.6	-10.4	-0.2	0.7
Services	-0.7	-0.8	-0.7	-2.6	-2.3	-6.9	-3.0	-2.2
Government	2.3	-	2.3	-1.2	-	-7.5	-	2.3
Refined Oil	2.2	2.1	2.3	-12.3	3.7	-18.7	5.9	6.8
Coal	-2.1	-2.1	-2.1	-4.3	-2.5	-10.0	-4.6	-3.8
Crude Oil	-4.0	-4.0	-4.0	-12.3	-12.6	-10.2	-16.1	-15.4
Electricity	-0.1	-0.1	-0.1	-4.8	-1.2	-10.4	-1.3	-0.5
Change in Over-all Return to Capital							-0.90	
Change in Wage Rate								-1.50
Simulation 2: Carb-Tax								
Agriculture	0.1	0.0	0.1	-0.1	-0.2	2.8	-0.1	0.1
Light Manufacturing	0.0	0.0	0.0	0.0	-0.2	1.9	-0.2	0.0
Heavy Manufacturing	-0.1	-0.2	0.1	-0.1	-0.5	6.4	-0.6	-0.4
Transport	-0.3	-0.3	-0.3	0.9	-0.4	3.5	-0.8	-0.5
Services	0.1	0.1	0.1	0.0	-0.1	1.8	0.0	0.2
Government	0.1	-	0.1	-0.1	-	2.1	-	0.0
Refined Oil	-0.9	-0.9	-0.9	1.4	-2.2	2.8	-3.1	-2.9
Coal	-0.3	-0.3	-0.2	0.5	-0.4	3.4	-0.7	-0.5
Crude Oil	-0.3	-0.3	-0.3	-0.6	-1.1	3.5	-1.4	-1.2
Electricity	-0.1	-0.1	-0.1	1.1	-0.6	3.6	-0.7	-0.5
Change in Over-all Return to Capital							-0.23	
Change in Wage Rate								-0.22
Simulation 3: Trad-Car								
Agriculture	-0.4	-0.5	-0.4	-1.7	-1.6	-6.5	-2.0	-0.9
Light Manufacturing	0.7	0.7	0.7	-0.7	-0.1	-5.3	0.6	1.7
Heavy Manufacturing	0.2	0.1	0.5	-1.1	-1.0	-2.0	-0.9	0.2
Transport	0.1	0.1	0.1	-3.1	-1.0	-7.3	-0.9	0.2
Services	-0.7	-0.7	-0.7	-2.6	-2.4	-5.3	-3.1	-2.0
Government	2.3	-	2.3	-1.3	-	-5.6	-	2.3
Refined Oil	1.3	1.2	1.4	-11.3	1.5	-16.4	2.7	3.8
Coal	-2.3	-2.3	-2.3	-3.9	-2.9	-7.1	-5.2	-4.1
Crude Oil	-4.3	-4.3	-4.3	-12.8	-13.5	-7.2	-17.2	-16.3
Electricity	-0.2	-0.2	-0.2	-3.9	-1.7	-7.2	-1.9	-0.9
Change in Over-all Return to Capital							-1.07	
Change in Wage Rate								-1.72

Where: KLEVA:capital-labor-energy value added, KLVA: capital-labor value added, EVA: energy value added, PKLEVA: price of capital-labor-energy value added, PKLVA: price of capital-labor value added, PEVA: price of energy value added, r: return to capital, l: labor

Household Income and Consumer Prices: The changes in household income, household disposable income, and consumer prices are shown in Table 12. All households experience a reduction in income due to the reduction in the average returns to capital and labor wages (0.9 and 1.5 percent respectively). Moreover, the reduction in households' disposable income is higher as the government increases the income tax rates imposed on households in order to offset the foregone tariff revenue as a result of tariff reduction. The changes in household disposable income vary by educational attainment with disposable income of household heads with college education decreasing more as they experience a higher increase in income tax rates owing to the progressive nature of income taxes. Moreover, the reduction in disposable income is higher among urban inhabitants compared to rural dwellers as the former are mostly employed in the formal sector, thereby bearing the burden of higher income tax payments.

The cost of household specific consumer basket falls for all households as a result of the tariff reduction. The fall in the cost of household specific consumer basket is lesser than the reduction in disposable income for most households, except among urban household heads with at least a high school education, and rural household heads with college education.

Table 12: Effects on Household Income and Consumer Prices (in percent Changes)

		Trad-Lib			**Carb-Tax**			**Trad-Car**		
Household Head		**δYh_h**	**δYdh_h**	**δPc_h**	**δYh_h**	**δYdh_h**	**δPc_h**	**δYh_h**	**δYdh_h**	**δPc_h**
URBAN										
Elementary	**Male**	-0.97	-3.54	-5.43	-0.20	-0.04	0.09	-1.16	-3.57	-5.35
	Female	-0.87	-4.37	-5.22	-0.17	0.04	0.11	-1.04	-4.32	-5.13
High School	**Male**	-0.89	-5.78	-5.23	-0.18	0.11	0.11	-1.07	-5.65	-5.14
	Female	-0.73	-6.77	-5.00	-0.14	0.22	0.13	-0.87	-6.54	-4.90
College	**Male**	-0.95	-15.00	-4.78	-0.19	0.66	0.14	-1.13	-14.31	-4.67
	Female	-0.79	-10.08	-4.84	-0.15	0.41	0.13	-0.93	-9.66	-4.74
RURAL										
Elementary	**Male**	-1.05	-2.33	-5.58	-0.21	-0.13	0.09	-1.25	-2.45	-5.51
	Female	-0.94	-2.79	-5.35	-0.19	-0.08	0.10	-1.12	-2.86	-5.27
High School	**Male**	-0.99	-3.70	-5.44	-0.20	-0.04	0.09	-1.18	-3.72	-5.36
	Female	-0.76	-3.06	-5.13	-0.14	0.00	0.10	-0.90	-3.05	-5.05
College	**Male**	-0.87	-8.84	-5.02	-0.18	0.30	0.11	-1.04	-8.52	-4.93
	Female	-0.66	-5.01	-4.93	-0.14	0.12	0.11	-0.80	-4.87	-4.84

Where: Yh_h: Income of household h; Ydh_h: Disposable income of household h; Pc_h: Cost of consumer basket of household h; δ: Change

Poverty: The changes in poverty indices (headcount, gap, and severity) are shown in Table 13. The national poverty headcount decreases by 2.4 percent, while the poverty gap and severity of poverty decreases by 4 and 5 percent respectively. The reduction in poverty gap and severity implies that the poorest of the poor have become relatively better off. The reduction in national poverty headcount is largely influenced by the reduction in poverty headcount among rural household heads with elementary and high school education, as well as urban household heads with elementary education as they experience a higher fall in their cost of household specific consumer basket relative to the reduction in their disposable income.

An examination of inter-household group poverty indices suggest that urban household heads with at least a high school education, and rural household heads with college education experience an increase in poverty. This is because the reduction in their disposable income is much higher than the reduction in the cost of their household specific consumer basket. The reduction in disposable income among these households is higher due to the burden of higher income tax payments.

Table 13: Poverty Impacts (in percent Changes)

Households		Simulation 1: Trad-Lib				Simulation 2: Carb-Tax				Simulation 3: Trad-Car		
		Index				Index				Index		
		Headcount	**Gap**	**Severity**		**Headcount**	**Gap**	**Severity**		**Headcount**	**Gap**	**Severity**
All Philippines		-2.4	-4.2	-5.4		0.2	0.3	0.4		-2.2	-4	-5.1
URBAN												
Elementary	Male	-2.5	-3.8	-4.6		0.1	0.3	0.3		-2.4	-3.6	-4.3
	Female	-0.8	-2	-2.4		0	0.2	0.2		-0.8	-1.9	-2.3
High School	Male	1.1	1.5	1.7		0	0	0		1.1	1.4	1.5
	Female	3.9	5.9	6.1		0	-0.3	-0.3		3.9	5.4	5.6
College	Male	35.5	42.9	46.7		0	-1.7	-1.5		33.8	40.1	43.7
	Female	13.6	52.2	80		0	-2.7	-3.6		13.6	48.6	72.7
RURAL												
Elementary	Male	-3.8	-6.2	-7.7		0.1	0.4	0.5		-3.4	-5.8	-7.2
	Female	-3.4	-5.2	-6.1		0.5	0.3	0.4		-3.3	-5	-5.8
High School	Male	-2.4	-3.9	-4.7		0.3	0.3	0.3		-2.4	-3.6	-4.4
	Female	-2.1	-4.5	-5.6		0	0.2	0.3		-2.1	-4.3	-5.4
College	Male	9.4	17.2	20.2		0	-0.8	-0.7		9.4	16.1	18.9
	Female	0	0.2	0.2		0	0	-0.2		0	0.1	0

By and large, college educated households regardless of area experiences the highest increase in poverty indices[10]. Within this group, urban male headed college educated households experiences a 35 percent increase in poverty headcount whereas, the urban female headed college educated households experiences the highest increase in poverty gap and severity of poverty. However, it should be noted that poverty indices among these households are relatively low at the benchmark. Hence in spite of the large variations in poverty indices shown in table 11, these household groups still have the lowest absolute poverty compared to other household groups. Poverty generally decreases in the rural areas (with the exception of college educated households) as they benefit from a much higher reduction in the cost of their household specific consumer basket.

9.2 Simulation 2: Carb-Tax

Macro Effects: The macroeconomic effects of imposing a 385 peso (1994 peso value) carbon tax results in a marginal reduction in over-all output (0.02 percent). The reduction in output results from a costlier production structure due to the increase in the relative prices of energy inputs. In turn, this leads to a 0.24 percent increase in consumer prices thereby resulting in a 0.02 percent decrease in consumption. The real exchange rate appreciates marginally (-0.07 percent) as the increase in the domestic cost of production (0.12 percent) makes Philippine made products relatively expensive abroad. Exports decreases by 0.07 percent while imports fall as lesser exports translates to reduced capacity to pay for imported goods[11]. The imposition of the carbon tax results in a 2 percent fall in carbon emissions.

Sectoral Effects: The carbon tax results in an output contraction for a majority of the sectors with the exception of agriculture and services which are relatively less energy intensive. The output contraction is greatest among energy producing sectors and the transport sector, whereas the light manufacturing sector experiences no change in output. As expected, the carbon tax brings about an increase in consumer prices (Pc_i) particularly among the energy producing sectors with coal experiencing the highest increase in

[10] With the exception of urban female headed college educated households
[11] This is due to the closure in the model which assumes of fixed current account balance.

consumer prices (17 percent). This is because coal is imposed the highest amount of carbon tax being the most carbon intensive fuel.

Value Added: The price of energy value added increases due to the imposition of the carbon tax, while the cost of capital-labor value added falls arising from the reduction in labor wages and the price of capital (0.23 and 0.22 percent respectively). The changes in the labor market is similar to the first simulation as demand for labor increases among output expanding sectors but falls among the output contracting ones. Thus, labor moves towards agriculture and services.

Household Income and Consumer Prices*:* All households experience a decline in income as the average returns to capital and labor wages fall by 0.22 and 0.23 percent respectively. However, the reduction in household income does not fully translate to a fall in household disposable income as the generated carbon tax revenue was used to reduce the income tax rates imposed among households. In fact, two thirds of all households benefits as they experience an increase in disposable income (these are: urban female headed elementary educated households; urban male and female headed high school educated households; urban male and female headed college educated households; rural male and female headed college educated households). In general, the changes in household disposable income vary by educational attainment and by place of inhabitant. Urban male and female headed college educated households experience the highest increase in disposable income as a result of a higher reduction in income tax rates[12]. Whereas urban male headed elementary educated households, rural male and female headed elementary educated households, and rural male headed high school educated households endure a reduction in disposable income. This is because they pay relatively lower taxes at the base thereby getting a lesser decrease in income tax rates.

The cost of household specific consumer basket increases for all households as a result of the carbon tax. By and large, it appears that the increase in the cost of consumer basket is lesser among low educated households. In a way, this suggests that low educated household's commodity basket contains lesser energy goods when compared to other households. The net impact of the changes in disposable income and consumer

[12] Since the reduction in income tax is pro-rated, these households experience the largest reduction in income tax rates.

prices vary among households. Elementary educated households in the urban area as well as households in the rural area with high school education or lower suffers as they experience an increase in the cost of their consumer basket outweighing the change in their disposable income.

Poverty: The national poverty headcount, poverty gap, and severity of poverty increases marginally (0.2, 0.3 and 0.4 percent) as a result of the carbon tax. Table 13 reveals that the changes in poverty indices across households are influenced by the changes in disposable income and the changes in the cost of consumer basket. This implies that households experiencing a higher increase in their cost of consumer basket relative to the change in disposable income experience an increase in poverty indices. On the whole, the changes in poverty indices are marginal across households with households benefiting from a higher increase in disposable income gaining a reduction in poverty gap and severity of poverty.

9.3 Simulation 3: Trad-Car

The tariff reductions brings about cheaper energy inputs which results in a 2 percent increase in carbon emissions. A carbon tax of 385 (1994 peso value) per ton of carbon emissions is necessary in order to maintain carbon emissions relative to 1994 levels under a liberalized economy.

Macro Effects: The macroeconomic effects are similar to the first simulation but lesser in magnitude due to the imposition of the carbon tax. The reduction in consumer prices is slightly less at 5.5 percent (compared to 5.7 percent in trad-lib) resulting in a smaller reduction in domestic production cost. Moreover, the real exchange rate depreciates less resulting in a marginally smaller increase exports. Over-all output increases by 0.17 percent, as the imposition of the carbon tax restricts the expansionary output impact of the tariff reductions.

Sectoral trade, output, and consumption: The carbon tax does not significantly alter the sectoral results observed from the first simulation. Both the output contracting and output expanding sectors remain the same. However, the magnitude of changes is marginally different with output expanding sectors generating a smaller increase in output, while output contracting sectors experiencing a higher reduction in output.

Similarly, the pattern of changes in prices are similar to the first simulation suggesting that the tariff reduction outweighs the cost impact of the carbon tax. An exception however is the 10 percent increase in the composite price of coal compared to the 6.7 percent dip under the trad-lib scenario—as coal is imposed the highest amount of carbon tax being the most carbon intensive fuel. On the other hand, the consumer price of refined and crude oil decreases as the reduction in tariff outweighed the cost impact of the carbon tax.

A comparison of coonsumer price changes reveals that the consumer price of refined oil, coal, crude oil and electricity is higher by 3, 16, 2, and 1 percentage points respectively under the trad-car scenario when compared to the trad-lib scenario. This results in a 0.7, 0.2, 0.9 and 0.1 percentage point reduction in the composite demand for refined oil, coal, crude oil and electricity respectively under the trad-car scenario.

Value Added: The Price of the energy value added (PEVA) still decreases as a result of the tariff reduction, although the decrease is slightly lower when compared to the trad-lib scenario because of the carbon tax. The price of capital-labor-energy value added (PKLEVA) still falls owing from the reduction in both the price of capital-labor value added (PKLVA) and the price of energy value added (PEVA). The fall in PKLVA is lower in this scenario because of a higher reduction in wages and the prices of capital when compared to the trad-lib scenario. Whereas the fall in (PEVA) is slightly less compared to the trad-lib scenario—as the reduction in energy prices due to tariff reduction is partially offset by the carbon tax.

Household Income and Consumer Prices: The lower return to capital and labor wages results in an income reduction for all households. The fall in household's income is higher under this scenario compared to trad-lib because of a higher reduction in both wages and return to capital. On the other hand, the magnitude of the reduction in disposable income is lower among low educated households. All households experience a marginally lower reduction in the cost of their consumer basket compared to the first simulation as the imposition of the carbon tax partially offsets the price reduction impact of tariff reduction.

Poverty: The national poverty headcount decreases by 2.2 percent, while the poverty gap and severity of poverty decreases by 4 and 5 percent respectively. Both the reduction in poverty among rural inhabitants and the rise in poverty among highly educated households is lesser compared to the first scenario. The former is due to a marginally lower reduction in consumer prices as the imposition of carbon taxes partially offsets the price reduction impacts of tariff reduction, while the latter is due to the carbon tax revenue recycling scheme. Over-all, the decrease in national poverty headcount, poverty gap, and severity of poverty is only marginally lower when compared to the trad-lib scenario in spite of the imposition of the carbon tax

11. Conclusion

The tariff reductions undertaken by the government reduced the cost of imported goods driving the domestic cost of production down thereby benefiting the outward-oriented and import-dependent manufacturing sector. Similarly, the tariff reductions increased over-all output and reduced the national poverty headcount, the poverty gap, and the severity of poverty.

The government policy of increasing income taxes to compensate for the foregone tariff revenue has varying effects among households. Households who pay relatively larger income tax at the base suffer, as the increase in income taxes—in order for the government to recover the foregone tariff revenue—reduces their disposable income significantly thereby offsetting the reduction in consumer prices brought about by the tariff reduction.

The Tariff reductions bring the cost of imported fossil fuels down, thereby resulting in an increase in carbon emissions. Imposing a carbon tax to reduce carbon emissions appears reasonable for a developing economy like the Philippines. The economic cost of imposing a carbon tax to maintain carbon emissions relative to 1994 levels appears marginal as the reduction in consumer prices due to the tariff reductions outweigh the increase in production cost from the imposition of a carbon tax. Although carbon taxes bring about a marginally costlier production structure, the changes in output and poverty indices are not significantly different from the no-carbon tax (trad-lib) scenario. In conclusion, the simulation results suggest that maintaining carbon emissions relative to 1994 levels appears to be a sensible alternative for the country.

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